# Image Cover Sheet

| CLASSIFICATION | SYSTEM NUMBER |
|---|---|
| UNCLASSIFIED | 518636 |

**TITLE**

Design and Implementation of a Software Tool for Human Factors Accident Investigation and Classification \(PCTACT\)

**System Number:**

**Patron Number:**

**Requester:**

**Notes:**

**DSIS Use only:**

**Deliver to:** CL

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **31 AUG 2002** | | **00-00-2002 to 00-00-2002** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Design and ImplementatiOn of a Software Tool for Human Factors Investigation and Classification (PCTACT)** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defence R&D Canada - Toronto,1133 Sheppard Avenue West,PO Box 2000,Toronto, Ontario M3M 3B9,** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES

14. ABSTRACT

**A software tool was designed arid Implemented that leads accident mvestigators through the steps of a Systematic Error and Risk Analysts (SERA), a classification scheme based on Perceptual Control Theory arid developed at DRDC Toronto The software presents ari mvesbgator with a senes of questiOns about an accident and generates conclusiOns about the nature of the fmlure and its probable pre-conditions A graphical depiction of the decisiOn tree allows users to navigate easily among the steps of the analysis At the end of the process, the software produces a report detailmg failures arid pre-conditions, and providmg eqmvalent terminology from the AGA 135 HF ACS classificatiOn scheme A help system was developed that makes context-sensitive help available to the user at vanous stages of the process In prehmmary work to lay a foundation for mtelhgent mdmg, users' activities are tracked by the software m a way that can be used m future to provide mtelhgent and adaptive help To Illustrate the potential use of the trackmg mechamsm, the software was designed to mom tor user actions and offer help whenever there is a long delay without input.**

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT **unclassified** | b. ABSTRACT **unclassified** | c. THIS PAGE **unclassified** | **Same as Report (SAR)** | **47** | |

THIS PAGE IS LEFT BLANK

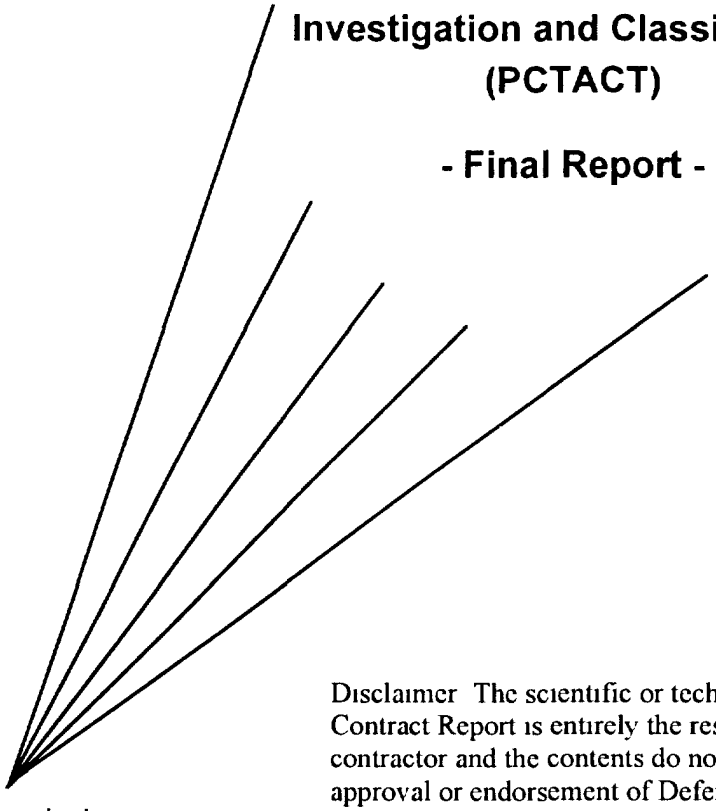
THIS PAGE IS LEFT BLANK

| | |
|---|---|
| Title | Design and Implementation of a Software Tool for Human Factors Accident Investigation and Classification (PCTACT) |
| Author | J L Edwards |
| Date | August 31, 2002 |
| Document No | DRDC Toronto CR 2002-168 |
| Contractor | Artificial Intelligence Management and Development Corporation<br>206 Keewatin Avenue, Toronto, Ontario M4P 1Z8, CANADA |
| Report No | AIM (AC242, August, 2002) |

Author J L Edwards, Artificial Intelligence Management and Development Corporation
Contractor. Artificial Intelligence Management and Development Corporation
206 Keewatin Ave., Toronto, Ontario, Canada M4P1Z8
Contract W7711-01-7756/001/TOR
Contract Scientific Authority
Mr Keith Hendy,
Head, Human Factors Research and Engineering Section
Establishment Defence R&D Canada Toronto (DRDC Toronto)
Document No DRDC TORONTO CR 2002-168
Date August 31, 2002
Report No AIM (AC242, August, 2002)

# Design and Implementation of a Software Tool for Human Factors Accident Investigation and Classification (PCTACT)

## - Final Report -





Artificial Intelligence
Management and Development Corporation
206 Keewatin Ave., Toronto, Ontario M4P 1Z8

## Abstract

A software tool was designed and implemented that leads accident investigators through the steps of a Systematic Error and Risk Analysis (SERA), a classification scheme based on Perceptual Control Theory and developed at DRDC Toronto The software presents an investigator with a series of questions about an accident and generates conclusions about the nature of the failure and its probable pre-conditions. A graphical depiction of the decision tree allows users to navigate easily among the steps of the analysis At the end of the process, the software produces a report detailing failures and pre-conditions, and providing equivalent terminology from the AGA 135 HFACS classification scheme

A help system was developed that makes context-sensitive help available to the user at various stages of the process In preliminary work to lay a foundation for intelligent aiding, users' activities are tracked by the software in a way that can be used in future to provide intelligent and adaptive help To illustrate the potential use of the tracking mechanism, the software was designed to monitor user actions and offer help whenever there is a long delay without input

## Résumé

On a conçu et mis en œuvre un outil logiciel qui aide les enquêteurs d'accident à exécuter les étapes d'une analyse systématique des erreurs et du risque (SERA), système de classification basé sur les principes du contrôle perceptif et développé par le RDDC Toronto Le logiciel présente à l'enquêteur une série de questions sur un accident et génère des conclusions sur la nature de la défaillance et les conditions préalables probables Une représentation graphique de l'arbre de décision permet aux utilisateurs de naviguer aisément parmi les étapes de l'analyse À la fin du processus, le logiciel produit un rapport détaillant les défaillances et les conditions préalables et fournissant la terminologie équivalente du système de classification du SACFH AGA 135

On a développé un système d'aide contextuelle auquel l'utilisateur peut avoir recours aux diverses étapes du processus Au stade préliminaire, en vue d'établir une fondation pour l'aide intelligente, les activités des utilisateurs sont suivies de près par le logiciel d'une façon qui pourra être utilisée à l'avenir pour offrir de l'aide intelligente et adaptative À titre d'illustration de l'utilisation potentielle du mécanisme de suivie des activités, le logiciel a été conçu pour surveiller les actions de l'utilisateur et offrir de l'aide lorsqu'il y a un intervalle prolongé sans entrée

This page intentionally left blank

# Executive Summary

A software tool was designed and implemented that leads accident investigators through the steps of a Systematic Error and Risk Analysis (SERA), a classification scheme developed at DRDC Toronto That scheme combines Information Processing and Perceptual Control theories into a model for investigating accidents and preventing future recurrences

The SERA tool presents an investigator with a series of questions about an accident and generates conclusions about the nature of the failure and its probable pre-conditions Users are able to modify responses to previous questions using a familiar "wizard" interface that contains choice points with "Next" and "Previous" buttons Introductory questions require textual descriptions and are followed by Yes/No questions with areas for adding additional remarks Answers to the Yes/No questions determine the user's path through a decision tree and result in sets of conclusions about active failures and concomitant pre-conditions If any conclusion does not agree with the user's understanding of the situation, SERA initiates a review of previous answers to help resolve the discrepancy

SERA includes a Flowchart Window with a graphical depiction of its decision tree The nodes of the tree are selectable and users can navigate quickly and easily among the steps of the analysis with a simple click of the mouse Pop-up labels provide brief descriptions of the nodes and appear whenever the user pauses the cursor over an item Nodes and links are coded by colour and shape to indicate their type and a legend appears in one corner of the flowchart window to help users discriminate among them

At the end of the process, SERA produces a report detailing failures and pre-conditions, and providing equivalent terminology from the AGA 135 HFACS classification scheme, currently in use by the Canadian Forces Users also have the ability to override the default HFACS terminology and specify other equivalents In addition to being able to export the report to a text file, which can be re-formatted easily in a word processor to suit the needs of the user, the complete file, containing all of the interface information, can be saved and returned to it at a later time

A help system was developed that makes context-sensitive help available to the user at various stages of the process Help screens can be accessed from most windows by clicking on a question-mark icon and additional explanations appear in pop-up windows when the user pauses the cursor over the description of a failure

In preliminary work to lay a foundation for intelligent aiding, users' activities are tracked by the software in a way that can be used in future to provide adaptive help To illustrate the potential use of the tracking mechanism, the software was designed to monitor user actions and offer help whenever there is a long delay without input The activities of the tracking mechanism are stored in a log of user actions maintained by the system Future work will modify those representations in ways that permit more effective intelligent and adaptive aiding for the SERA user

SERA was written in Java to provide maximum flexibility for future enhancements while ensuring cross-platform compatibility Versions have been delivered for Windows and Macintosh platforms, but in future the software could be ported to a variety of other systems, including web browsers and handheld devices such as the Palm or PocketPC thereby allowing investigators to conduct SERA analyses in the field

Edwards, J L 2002 Design and Implementation of a Software Tool for Human Factors Accident Investigation and Classification (PCTACT) AC242, DRDC Toronto CR 2002-168

# Sommaire

On a conçu et mis en œuvre un outil logiciel qui aide les enquêteurs d'accident à exécuter les étapes d'une analyse systématique des erreurs et du risque (SERA), système de classification basé sur les principes du contrôle perceptif et développé par le RDDC Toronto Ce système combine les principes du traitement de l'information et du contrôle perceptif dans un modèle pour enquêter sur les accidents et empêcher les récurrences futures

L'outil SERA présente à l'enquêteur une série de questions sur un accident et génère des conclusions sur la nature de la défaillance et les conditions préalables probables Les utilisateurs peuvent modifier leurs réponses aux questions précédentes au moyen d'une interface d'assistant familière qui contient des options avec des boutons Suivant (Next) et Précédent (Previous) Des questions préliminaires exigent des descriptions texte et sont suivies de questions de type oui/non avec des champs permettant d'entrer des remarques supplémentaires Les réponses aux questions oui/non déterminent le chemin de l'utilisateur dans un arbre de décision et donnent lieu à des ensembles de conclusions au sujet de défaillances actives et des conditions préalables connexes Si une conclusion donnée ne concorde pas avec l'interprétation de la situation par l'utilisateur, SERA lance une revue des réponses antérieures pour aider à résoudre la divergence

SERA comprend une fenêtre à ordinogramme avec une représentation graphique de l'arbre de décision Les nœuds de l'arbre sont sélectionnables, et les utilisateurs peuvent naviguer rapidement et aisément parmi les étapes de l'analyse au moyen d'un simple clic de la souris Des étiquettes instantanées donnent de brèves descriptions des nœuds, et elles apparaissent lorsque l'utilisateur arrête le curseur sur un nœud Les nœuds et les liens sont à code de couleur et de forme indiquant leur type, et une légende apparaît dans un des coins de la fenêtre à ordinogramme pour aider l'utilisateur à les distinguer les uns des autres

À la fin du processus, SERA produit un rapport détaillant les défaillances et les conditions préalables et fournissant la terminologie équivalente du système de classification du SACFH AGA 135, actuellement utilisé par les Forces canadiennes De plus, les utilisateurs ont la possibilité de surpasser la terminologie implicite du SACFH et de spécifier d'autres équivalents En plus de la possibilité d'exporter le rapport vers un fichier texte, qui peut être reformaté aisément dans un traitement de texte selon les besoins de l'utilisateur, le fichier complet, comprenant toute l'information d'interface, peut être sauvegardé pour y revenir plus tard

On a développé un système d'aide contextuelle auquel l'utilisateur peut avoir recours aux diverses étapes du processus On accède aux écrans d'aide à partir de la plupart des fenêtres en cliquant sur une icône à point d'interrogation, et des explications supplémentaires apparaissent dans des fenêtres instantanées lorsque l'utilisateur arrête le curseur sur la description d'une défaillance

Au stade préliminaire, en vue d'établir une fondation pour l'aide intelligente, les activités des utilisateurs sont suivies de près par le logiciel d'une façon qui pourra être utilisée à l'avenir pour offrir de l'aide adaptative À titre d'illustration de l'utilisation potentielle du mécanisme

de suivie des activités, le logiciel a été conçu pour surveiller les actions de l'utilisateur et offrir de l'aide lorsqu'il y a un intervalle prolongé sans entrée Les activités du mécanisme de suivi sont stockées dans un journal des actions utilisateur maintenu par le système Les travaux futurs modifieront ces représentations de façon à offrir à l'utilisateur de SERA de l'aide intelligente et adaptative plus efficace.

SERA a été écrit en Java pour offrir une souplesse maximale aux améliorations futures tout en assurant la compatibilité inter-plates-formes Des versions ont été livrées pour les plates-formes Windows et Macintosh, mais à l'avenir le logiciel pourrait être adapté à une variété d'autres systèmes, y compris les explorateurs Web et des dispositifs portatifs tels que les ordinateurs de poche Palm ou PocketPC, ce qui permettra aux enquêteurs d'effectuer les analyses SERA sur le terrain

# Table of contents

# Background

Identifying and eliminating factors that lead to accidents is essential to preventing future recurrences Due to advances in equipment reliability, accidents are more likely to be the result of human error than mechanical error To facilitate the investigation of human errors, it is useful to have a systematic process for analysing the causes of failures and conditions that lead to those failures One such system is the Perceptual Control Theory Accident Classification Tool (PCTACT[1]) (Hendy, 2002) While other accident investigation tools are based on descriptive models, SERA is grounded in a theoretical approach that combines Information Processing and Perceptual Control theories (Hendy, East, and Farrell, 2000; Hendy, Liao, and Milgram, 1997, Powers, 1973) SERA provides

- a tool for investigating the human factors causes of accidents and incidents,
- a means of classifying accidents and incidents, and
- the basis for a risk management tool

To prevent future accidents, their causes need to be identified and steps taken to eliminate the conditions that led to the errors Current accident investigation tools, such as the Human Factors Accident Classification System (HFACS) used by the Canadian Forces Directorate of Flight Safety, have been developed by analysing factors that contributed to a series of specific accidents Because they lack a sound theoretical foundation, it is difficult to say whether they model cause and effect relationships in a consistent and reliable manner In contrast, SERA provides a theoretical basis for identifying cause and effect relations in accident investigations and is subject to checks on consistency and completeness as well as reliability and validity

In addition to helping determine the type of failure that occurred, SERA identifies the most likely pre-conditions that led to the failure These are conditions that would have to be changed in order to prevent a recurrence of the incident A significant advantage of SERA is that it provides a more comprehensive taxonomy of failures and pre-conditions than existing accident investigation and classification tools like HFACS HFACS (Shappell and Wiegmann, 2000) was developed by analysing a database of specific accidents, so there is the risk that its taxonomy is incomplete or redundant due to limitations in the data In contrast, the theoretical underpinnings of the SERA model help ensure the development of a consistent and complete taxonomy

In order to facilitate the use of the SERA model, a software representation of the system is needed to provide accident investigators with an efficient way to perform SERA analyses Such a software tool also would facilitate the collection of data that could help refine the SERA model itself This project aims to address these issues

---

[1] Throughout the rest of this report, the name of the software will reflect the recent name change of "Systematic Error and Risk Analysis" and the associated acronym, "SERA."

The purpose of this contract will be to design and build a software tool that will lead accident investigators through the steps of a SERA analysis The software tool will present the investigator with a series of questions and analyse the respondent's answers in terms of the source of failure and pre-conditions that led to that failure In addition to providing standard, context-sensitive help to the user, the tool will lay a foundation for intelligent aiding and incorporate one or more examples in the final implementation

# Research Approach

Using IP/PCT theory and Hendy's derived SERA conceptual tool, a comparable software system was to be designed and implemented The software tool would take a user through a step-by-step process that characterizes accidents in terms of active failures and their pre-conditions and would be designed for accident investigators as they gather information in the field The principal elements of the program were to be. an easy to use interface, standard and intelligent help, and, cross-comparisons to similar results from the HFACS tool

The proposed SERA tool would be designed to lead the investigator through a series of yes or no questions modelled on Hendy's flowcharts These questions would follow decision ladders which lead to conclusions about the active failures that caused the accident and the pre-conditions that led to those failures At the conclusion of the question-answering phase, the SERA tool would present the user with a report detailing the type(s) of failure that led to the accident and the associated pre-conditions, as well as equivalent terminology from the Canadian Forces modified AGA 135 HFACS specification

Help would be made available to the user at each stage in the process For each question presented, context-sensitive help would be readily accessible including definitions of terms and descriptions of factors to consider in answering the particular question A graphical overview of the line of questioning was to show where the user is in the process thereby providing a better understanding of the overall procedure The software also was to incorporate a foundation for intelligent aiding by tracking an investigator's interface actions Among other things, the user interface tracking was to include information about the timing of the user's input, allowing the system to offer help to the user when it detects a long delay in answering a question

## Study Objectives and Work Items

The following study objectives and work items were identified for this project:

- To design and build a software tool that will lead accident investigators through the steps of a SERA analysis The software will have the following features
    - A clear, intuitive interface that presents the user with a series of questions based on the decision ladders outlined in the Hendy's PCTACT (SERA) technical report
    - Summary conclusions about the nature of the failure and probable pre-conditions that could have led to that type of failure
    - A report detailing these findings
    - A revision support function allowing users to modify responses to previous questions

    - Context-sensitive help at each stage of the analysis, with definitions of terms and other relevant background information presented

- To construct a database to accommodate the results of SERA analyses and link the SERA tool with that database
- To provide for cross-comparisons to HFACS terminology
- To provide support for intelligent aiding in the following forms:
    - Tracking of user interface actions,
    - Offering of help when there are excessively long delays without user input,
    - Offering of help in the face of apparent confusion on the part of the user (e.g when the user repeatedly returns to modify answers to previous questions),
    - Possibly incorporating an information-retrieval agent for obtaining up-to-date information on failures and pre-conditions from the world wide web

# The Main SERA Window

The main SERA window presents information in a variety of formats, depending on where the user is in the process These screens include preliminary information on the investigator and the accident; descriptions and remarks about the unsafe act and the perceptions, goals and actions of the crew; Yes/No questions, conclusions about failures, candidate pre-conditions; help, conflict resolution, and report Following a description of the introductory splash screen and the nature of navigation within the SERA software tool, detailed descriptions of these screens are given

## Splash Screen

This screen appears when the program is first launched and can also be triggered from the "About SERA" item in the Help Menu The window includes the title of the software, the author and commissioner of the software, and copyright information The accompanying graphic depicts a CF-18, a Halifax-class frigate and a Coyote personnel carrier (representing the three services of the Canadian Forces) as well as a maintainer working on a CF-18 The splash screen can be dismissed by clicking anywhere in the window

## Navigation

Navigation among the questions in the SERA analysis is accomplished by using "Next" and "Previous" buttons which are located in the bottom-right corner of each screen This enables users to easily move among the questions and conclusions in the same familiar manner that they would navigate in a standard "wizard" interface

The primary benefit of navigating using the "Next" and "Previous" buttons is that it provides a simple way for the user to return to examine prior responses while preserving the state of all subsequent answers

Users can also navigate by clicking items in the flowchart window This allows the user to rapidly move to other locations in the decision tree without the need to repeatedly click the "Next" and "Previous" buttons (See the "SERA Flowchart Window" section below )

Each time the user navigates to a new screen, a transition effect, much like those used in PowerPoint and other presentation software, is used to give a visual cue as to the direction of the movement in the decision tree Downward motion in the tree is conveyed by scrolling the new screen up from the bottom Similarly, lateral movements in the tree result in the new screen scrolling from the right side of the window Box-out transitions are used in situations where the user is jumping ahead to a discrete location in the decision tree When the "Previous" button is clicked, the transitions move in the opposite direction A horizontal blind effect is used when help is presented, and the effect is reversed when the help is dismissed

## Introduction Screen

This screen presents the investigator with a brief description of the software and prompts the user to enter some basic information This includes the author, the author's unit, the title of the report, a brief description of the incident, and the dates and times of both the incident and the entry of the report When the program is first launched, the report date and time are filled in automatically with current values

The user can click on the asterisked(*) "Perceptual Control Theory" footnote at the bottom, left-hand corner of this window Doing so brings up a brief description of the theory for interested users

## Questions Requiring Textual Responses

There are two types of question in the SERA tool those that require textual answers from the user, and those that need a "yes" or "no" response The first four questions in the analysis are of the first type and the remainder fall into the second category The Yes/No question screens also provide a place to enter textual responses and, for each question, this area is appropriately labelled so as to provide guidance to the user on the nature of the descriptions to be entered

The first four questions require the user to identify the following

- the unsafe act that led to the accident,
- the crew's perceptions as they relate to the unsafe act,
- the goals of the crew, and,
- the crew's actions

Textual answers are entered into an editable text area which follows each question A second text area allows the entry of any additional remarks the investigator may have These remarks provide details on the incident being investigated that can be useful to other investigators reviewing the results

## Questions Requiring "Yes" or "No" Responses

The question screens that call for "Yes" or "No" responses form the backbone of the SERA decision trees The user's answers to these questions determine the path through the decision

tree and thereby result in conclusions about the active failures and concomitant pre-conditions which led to the accident

In the early stages in the development of this software, the yes or no answers were selected using radio buttons, which due to their nature had the potential to mislead the user into thinking one answer was more probable or desirable than another To avoid this problem, a new interface element was designed using "Yes" and "No" labels that appear below each question When a question is first displayed, neither item is highlighted To provide feedback to the user that the items are selectable, a faint grey ellipse encircles each item when the mouse pointer passes over top When the user selects either "Yes" or "No", that item is circled in white to indicate the user's choice

As with the first four questions, there is a text area which permits the entry of any additional remarks the user may have In the case of the Yes/No questions, the title of this text area changes according to the particular question This guides the user to provide specific information relevant to that question

## Conclusion Screens

When the user has answered enough questions for the software to come to a determination about failures that may have occurred, this information is presented in a conclusion screen Each conclusion screen gives the user a list of one, two or three possible failures depending on the context If none of the conclusions seems appropriate to the user, the following, additional choice is available "The above conclusion(s) do not fit with my understanding of the situation " Selecting this option and clicking the "Next" button takes the user to the confirmation process, described below

If one of the conclusions does suit the situation, the user selects the associated checkbox to the left of the description and proceeds to the pre-conditions screen

The user can obtain additional information about a particular conclusion by pausing the mouse pointer over top of that description A pop-up window appears with a more detailed description of the failure This feature keeps the quantity of text in the window to a minimum and eliminates the need to scroll

## Pre-Condition Screens

A pre-condition screen appears after the user has chosen one of the possible failures in a conclusion window and clicked the "Next" button In the first part of this screen is a list of the *most likely pre-conditions* given the type of failure that occurred The next section contains *general pre-conditions* that could be factors in any type of failure Each item in

these sections has a Yes or No option next to it that can be selected according to whether or not the user believes that item contributed to the failure

The last question on the screen asks whether the user believes there are other pre-conditions that may have played a role in the failure If "Yes" is selected then the next screen in the process will be the "Additional Pre-Conditions" screen, described below Otherwise, the questioning continues at the top of the next branch of the decision tree

## Additional Pre-Conditions Screen

This screen is invoked when the user indicates from the pre-conditions screen that there are additional pre-conditions that do not fall into any of the pre-defined SERA categories There are two text areas, each allowing the entry of an additional pre-condition If there are three or more to enter, any remaining ones can be typed in the third text area To the right of each of these boxes is an associated text area to accommodate an explanation of why the user believes that pre-condition was a factor in the accident

## Confirmation Process Screens

The confirmation process is undertaken when the user finds that the possible conclusions offered by the software are not consistent with his or her understanding of the accident situation The final choice in each conclusion screen is checked when the user feels that none of the conclusions is appropriate to the situation When the associated checkbox is selected and the "Next" button is pressed, the software presents the user with a series of screens summarizing each question and the user's answer For each one, "Yes" or "No" can be pressed to indicate whether the original answer was correct or not The process can be stopped at any time by clicking the "Cancel" button, whereupon the user is returned to the conclusion screen that was displayed before the confirmation process began

If, during the process, the "No" button is pressed, the user is returned to that earlier question so that the answer can be revised Alternatively, if all of the questions are answered "Yes" then the original responses are judged to be correct and the user has the option of re-examining his or her choice of conclusions, starting over, or exiting the application

## Analysis Completion Screen

When the investigator has finished answering all of the questions in the decision tree, a screen is presented to inform him that the analysis is complete At this point, the user has the option of viewing a report summarizing the findings of the analysis or reviewing the additional pre-conditions

## View Report Screen

This screen is accessed from the "Analysis Completion" screen and can also be viewed at any point in the process by selecting the "View Report" option in the "View" menu It presents a report summarizing the current results of the analysis The contents of this report can be output to a text file by selecting "Export " in the "File" menu

The report is divided into three sections corresponding to the three branches of the decision tree perception, goal (intent) and action Within each section, the user's responses and the failures and pre-conditions are listed The questions and answers are rephrased as statements to facilitate the integration of this information into an investigator's personal report Pre-conditions are grouped according to whether the user answered "yes," "no" or neither

## Review "Other" Pre-conditions

This screen is accessible through a button in the "Analysis Completion" screen It provides a simple mechanism by which the user can return to the "Additional Pre-conditions" screens to revise or add to those responses This option was incorporated to give the user additional flexibility in the timing of this input

# The SERA Flowchart Window

The flowchart window appears to the right of the main window and gives a graphical overview of the decision tree It tells users at a glance where they are in the process and where they have been

## Node and Link Representations

In the flowchart, questions are represented as blue rectangles Conclusions start out as blue circles, but when a particular failure is identified during the analysis, that circle becomes a red six-pointed star to facilitate rapid identification of failures in the flowchart Pre-conditions appear as blue ellipses in this window "Yes" answers to questions are shown as green links, and "no" answers appear red to enable the user to quickly see where in the decision tree a particular response will lead

At the start of the process, the shapes in the flowchart are drawn only in outline As the user answers questions, those nodes are filled in, clearly showing the path that the user has followed The node corresponding to the currently-displayed information is drawn with a bold outline When the user returns to a previous node in the flowchart, the bold outline moves to reflect the change to the current focus and the shading remains in place for all other answered nodes to indicate where in the tree the user has been

## Legend and Labelling

In the upper, left-hand corner of the flowchart window is a legend which identifies the various shapes and colours of the nodes and links in the flowchart, and what they represent The three branches of the decision tree, corresponding to Perception, Goal (Intent) and Action, have been labelled to further provide context for the user

## Sizing and Scalability

The flowchart window is scalable to allow the user to expand or contract it according to the screen space available Restrictions on the minimum size of the window have been imposed to prevent reducing the window beyond the point of legibility

## Flowchart Navigation and Associated Constraints

In addition to providing a graphical depiction of the user's location in the process, one of the primary purposes of the flowchart window is to allow the user to navigate to any point in the analysis with a click of the mouse button

The user is able to navigate to any screen that has already been visited, corresponding to nodes that are shaded in the flowchart Additionally, the first question in each of the three branches of the decision tree can always be clicked This allows the user full flexibility for beginning the questioning in any of the three branches Unshaded nodes below these questions cannot be selected because the software cannot determine a unique path when the yes and no questions above have not been answered

# Menu Commands

It is standard for applications to have at least a "File" menu, an "Edit" menu and a "Help" menu SERA has these, as well as a "View" menu For maximum usability, the menus have been designed to contain the typical items users expect to see The remainder of this section contains descriptions of the various menu items for each of the SERA menus

## File Menu

The "New" command in this menu allows the user to clear all of the current answers and start over with a blank report

The "Open" command presents the user with a standard file dialog box and will open up a selected report that was previously stored using the "Save" command

The "Save" menu item stores all of the information that has been entered in the current report in a single file This file uses a proprietary file format that is not designed to be human-readable or editable The exact state of the software is preserved when this command is invoked

When the user wishes to specify a new name for the file, the "Save As " command will allow this

The "Export " command will output a summary of the results of the SERA analysis to a text file

The "Quit" menu item allows the user to exit the application

## Edit Menu

The "Edit" menu items function as they do in most applications These commands allow the user to manipulate text in the editable text boxes within the software

The "Cut" command deletes the currently selected text and places it in the clipboard, while the "Copy" menu item copies it to the clipboard without deleting it first The "Paste" command inserts the contents of the clipboard at the current location of the insertion point The "Clear" command deletes the text currently selected The "Select All" command allows the user to select all of the text in the text area that is currently being edited

## View Menu

The "View" menu allows the user to select between two different viewing modes in the application When the programme is first launched, it is in "View Questionnaire" mode Through the "View" menu the user can toggle to "View Report" mode and back to the questionnaire This enables the user to examine a summary of the findings at any point in the process and return to the questions without losing her place

## Help Menu

The "About SERA" menu item invokes the SERA splash screen, described previously

The "Page Help" option brings up a help screen with information relevant to the current window, if such help is available

In the Macintosh version of SERA, the system automatically inserts three additional menu items at the top of the "Help" menu. The first two, "About Balloon Help" and "Show/Hide Balloons" are standard Macintosh menu commands available in all applications. The third item, "Show/Hide Contextual Menus" has no functionality in this software. These menus do not appear in the Windows version of SERA.

## Storage of Textual and Flowchart Data

The software was designed to allow convenient modification of all textual information presented in the programme This material is stored in a single editable text file, which means that there is no need to modify programme code in order to revise the questions, conclusions, pre-conditions or help information

Also stored in this file is information about the logic of the decision trees and the geometry of the flowchart This leads to the possibility of modifying not only text, but the sequence of questions and conclusions, or even the entry of additional questions Some of these changes could require minor modifications to the programme code, but future versions of the software could allow full flexibility in this regard

The text file is divided into separate entries corresponding to the various screens in the software, and they are delimited by strings of pound ("#") symbols Each entry contains some or all of the following information, depending on the type of screen to which it corresponds the text of the question, conclusion, pre-conditions or help, position in the flowchart, title for the "additional remarks" area, and a re-wording of the question in the form of a statement for entry into the report

# File Input and Output

## Proprietary File Format to Save and Restore the Current State

The current state of the analysis can be stored at any time using the "Save" or "Save As . " command in the "File" menu, and can be retrieved later using the "Open" command in the same menu This capability makes use of a proprietary file format to store all data that have been entered by the user This includes

- answers to the introductory questions (author, unit, title, description, dates and times),
- textual answers,
- answers to the "yes" or "no" questions,
- conclusion choices,
- pre-condition information,
- additional remarks

## Exporting the Report to a Text File

The report that is available to the user at the end of the analysis can be output to a text file through the use of the "Export " command in the "File" menu A discussion of the format of this report is found under "View Menu" in the "Menu Items" section, above

# Standard Help System

There are three components to the standard help system in SERA contextual help is available for specific pages, help windows display detailed information about failures, and there is a single help screen providing background information about perceptual control theory

## Contextual help

Contextual help is available for all of the question, conclusion and pre-conditions screens The content of the help is derived from Hendy's PCTACT (SERA) report As such, it mostly provides general information on the SERA process and lacks specific guidance on the use of the software Future work on SERA could address this issue

There are two methods of invoking contextual help clicking the question mark icon in the upper right-hand corner of the window and selecting "Page Help" in the "Help" menu The help appears using a horizontal blind transition effect It can be dismissed by clicking the "Return" button, or by clicking anywhere in the window The help information is dismissed using a reverse horizontal blind effect If a particular screen lacks a question mark icon, there is no help available for that screen

## Pop-up Windows Containing Supplementary Information about Failures

In any of the conclusion screens, the user can pause the cursor over a particular conclusion to bring up a window containing a more detailed description The cursor must pause for approximately a second before the help window will appear, to reduce the likelihood that a user might trigger it unintentionally When a help window is displayed, the user cannot proceed until this window has been dismissed by clicking anywhere within its boundaries

The descriptions of the failures are taken from Annex B of Hendy's report The first sentence about each failure appears in the main conclusion window and gives a brief description of that item This allows the user to view all of the choices without the need to scroll The full text of the description appears in the pop-up window, which is sized according to the amount of text to be displayed and positioned to appear below the description in the main window

## Perceptual Control Theory Overview

In the introductory screen the user can click on the asterisked(*) PCT label in the lower left-hand corner to bring up a screen containing a brief overview of Perceptual Control Theory

This feature was added because many users will not have had prior exposure to this theory, and some understanding of it is necessary in order for users to provide meaningful answers to the questions in the SERA analysis

## Intelligent and Adaptive Help

The goal of the intelligent and adaptive help component of this contract was limited largely to creating an infrastructure to track user actions and exploring how that infrastructure could be used to add adaptive functionality to future versions of the software One simple mechanism was incorporated in this version but future work could create a more comprehensive help system Some of these are described in the "Opportunities for Future Enhancements" section below

To lay the groundwork for an intelligent and adaptive aiding system, user interface actions are monitored by the software These include activities such as clicking the mouse on a push-button, selecting a checkbox, and choosing a "Yes" or "No" answer The context of the action is also stored, including the interface object involved, where the user is in the process, and time-stamp information

Future work could extend interface monitoring to include inference of the user's goal in performing a particular action, and making judgements about how that action might fit into a larger plan That information could then be used to determine what the user is trying to accomplish and thereby providing the basis for assistance to further that aim This could include queries to validate the user's intended plan, help descriptions tailored to the pursuit of that plan and, even automation of select processes in the service of the user's goals

A simple example of a current intelligent help capability is the provision for help when there is a long delay without input from the user The software implicitly infers from this delay that the user may be having trouble deciding how to proceed and therefore should be offered assistance The system then displays a help dialog box asking if help is needed and, if so, takes the user to a help page specific to that context

If a user is collecting information in the field, there may be delays as materials are being gathered To prevent this help feature from becoming a nuisance to the investigator, these automatic messages may be disabled by clicking a standard, "Don't Show Again" checkbox before dismissing the window

Since the user's actions are being tracked, there is the potential for the system to determine whether a user has gone back to revise earlier responses In future, this fact could be used as an indication that the user is experiencing confusion about how to answer the questions, and the system could offer appropriate help This feature was considered for implementation in the current version of the software, but it was determined that a more fundamental issue should take precedence, namely resolving conflicts between the system's conclusions and the user's understanding of the accident situation Consequently, a "confirmation mechanism" for resolving those conflicts was designed and implemented as part of the current work

Also considered for the help system was the possibility of incorporating an information retrieval agent Because the software has been written in Java, it is well suited to the integration of an agent technology to access the internet Since the information on the world-

wide-web is constantly changing, there is the potential for retrieving more current information about failures and pre-conditions than could be obtained using a static help system.

Discussions were held regarding possible designs for such an agent. Prior experience constructing information-retrieval agents in other contexts would facilitate the design and implementation of an agent for SERA. Initial work could allow the automated searching of one or more general Internet search engines. A second phase could incorporate the retrieval of information directly from sites with content that is specific to accident investigation

## HFACS Equivalents and Database Output

All of the failures and pre-conditions have been associated with equivalents from the AGA 135 HFACS accident investigation system currently used by the Canadian Forces The category equivalents were derived from Tables 3 through 6 in Hendy's report That information is incorporated into the report that SERA produces at the end of each analysis For each failure and pre-condition, the name of the equivalent HFACS category is provided

An original goal for this contract was to link this software with a database of accidents that have been investigated using the HFACS approach As a consequence of other work on the project and after discussions with the Scientific Authority, specifications for how that information is to be organised for inclusion into a database and the implementation of that function were deferred to future contract work

The exported report at the end of the analysis contains all of the information that would be contained in a database entry In future, when a format for the database has been determined, the software could be modified to output the report in a form suitable to that database

# Contract Extension

Upon completion of the first phase of the SERA work it was determined that several features were missing from the programme — features that had emerged as essential to the software but which had not been included among the original work items The contract was extended to allow for the inclusion of these items, which are described below

## Remarks for the Individual Pre-conditions

One feature the original SERA implementation lacked was the ability to enter remarks for each pre-condition This is important because there is a need for the investigator to justify why a particular factor was or was not a precursor to the failure that occurred

In order to avoid interface cluttering, an approach was devised that permitted the use of the existing area for typing in comments in the pre-conditions window When the window first appears, the heading above that text area indicates the pre-condition to which the remarks apply, e g , "Additional Remarks for MONITORING AND SUPERVISION " As the user answers yes or no to the remaining questions, the heading changes to indicate that the remarks apply to that pre-condition and the contents of the text area update accordingly.

## HFACS Equivalent Categories

The original implementation of SERA had the capability of generating a report detailing equivalent HFACS terminology for each conclusion and pre-condition based on the SERA-HFACS mappings given in tables 3 through 6 of Hendy's (2002) report This arrangement gave no flexibility for the investigator to tailor HFACS results to the particular accident under investigation As a consequence, a way was devised to override the suggested equivalents

That capability was incorporated through the addition of an "HFACS" button in the conclusion and pre-condition windows When selected, the button invokes a new "HFACS Equivalents" window containing a list of the 24 categories from the AGA 135 HFACS standard Each item has an associated checkbox and, when the window first opens, Hendy's suggested equivalents are pre-selected The user then has full flexibility to deselect any default categories that are not suitable and to select other items that are relevant to the particular conclusion or pre-condition

In the conclusion window, the "HFACS" button is dimmed and cannot be selected until the user has chosen one of the possible failures In the pre-conditions window, answering one of the "yes" or "no" questions changes not only the mode of the remarks area, described above, but also tells the system the pre-condition to which the HFACS equivalents apply

It is important to note that the same 24 HFACS categories are available for both the conclusions and pre-conditions While it is the case that certain HFACS categories are associated with failures and others relate to pre-conditions, Hendy has demonstrated that there are situations where, for example, a SERA failure will be equivalent to an HFACS pre-condition It is for this reason that all HFACS choices are made available to the user each time the window is invoked, giving the investigator maximum flexibility

To complete the implementation of the new HFACS support and the remarks for the individual pre-conditions, data structures were added to store this extra information Furthermore, the Save and Open commands were modified to accommodate the additional data and compatibility with the original file format was maintained so that old data files could still be opened Lastly, the report output was altered to integrate the new data

## Report Output

The format of the report output required modifications, both to accommodate the new information mentioned above and to enhance readability Conclusions were re-organised so that the type of failure was followed immediately by the HFACS equivalent information, which in turn was followed by any remarks entered by the user This format has the advantage of grouping the information logically instead of presenting it topically, thus eliminating the need for the user to jump to various parts of the report for related information The same re-organisation was applied to the pre-conditions

Wordings in the report were also changed to improve readability The descriptions of the conclusions and pre-conditions were minimised to reduce the length of the report and the pre-conditions were re-worded so that they appear as statements rather than questions

In response to user feedback on the readability of the report, an extra sentence was added before each set of pre-conditions answered "No " The change was made to indicate more clearly that those are factors that *do not* contribute to the accident under investigation The added sentence reads, "NOTE These pre-conditions ARE NOT considered to be contributory "

## Implementation Platforms

Candidate implementation software were C and Java running on Microsoft Windows platforms Although the SERA tool could be developed using a wide variety of other software languages, e g , Visual Basic, it was decided that the use of C or Java would allow greater flexibility for future enhancements Both languages allow for portability to other hardware platforms and integration with software agents The use of Java permits implementation as both a stand-alone application and as an applet accessed via the world-wide-web and executed in a web browser

Java was chosen for this implementation because it is the more portable of the two languages, thus providing the most flexibility for future Internet capabilities The Windows compatibility enables the software to run on the majority of laptop computers, thus giving greater scope for use in the field

The first phase of SERA development took place on the Macintosh using Metrowerks CodeWarrior software It was then ported to the Windows platform using Metrowerks for the PC As expected, modifications to the Java programme were necessary due to differences in the behaviour of the two operating systems Contract extension work followed a similar path of intial development on the Macintosh and a subsequent port to Windows on the PC Versions for both platforms are now available

The flexibility of Java is unmistakable Due to its portability, there is the potential in future to produce versions of SERA that would run on Sun Solaris systems, UNIX/LINUX boxes, Windows CE and other PDAs, and even in browsers over the web

# Opportunities for Future Enhancements

Future work on the software could encompass some or all of the following items

## Add support for stylised text

This would enable bold, italic and underlined text to be used in the questions, conclusions and help descriptions

## Implement an automatic save mechanism

This could be designed to automatically save a backup file periodically while the investigator is conducting an analysis In the event of a system crash, most if not all of the entered information could be recovered from this file the next time the application was launched, much as it is handled in Microsoft Word, for example

## Implement a Palm or PocketPC version

This would allow a user to perform a SERA analysis in the field using a PDA or other handheld device

## Create a web site implementation

Because the software has been written in Java, much of the interface could be adapted for use on a web site with minimal modifications to the programme code One major area that would need to be redesigned would be the storage of the report at the end of the analysis This is due to security restrictions imposed in Java that prevent programmes that are running in a web browser from accessing a user's local hard drive

## Incorporate risk management analysis

Hendy's report discusses methods for applying the perceptual control theory to risk management assessments These techniques could be incorporated into a future release of the SERA software

## Validate the theory

A study could be done to systematically compare the results of SERA analyses with those of an established accident classification tool such as HFACS Statistical analysis could shed light on the efficacy of the SERA approach

## Create pop-up labels in the flowchart window

This would provide pop-up description labels in the flowchart window when the user paused the mouse pointer over a particular node

## Expand the contextual help materials

The material in the contextual help system would benefit from revisions and additions The current help has general information about the SERA process, but lacks specific material on the features and use of the software tool One or more "instructions" screens could be added, as well as more detailed descriptions of the individual pre-conditions

## Extend the tracking capabilities

The help system could be extended to allow more elaborate tracking of user actions In the current version of the software, certain interface actions are not monitored, such as repositioning windows or moving the mouse over a "Yes" or "No" button causing it to be highlighted This information could be incorporated into a model of the user

## Intelligent Adaptive Aiding

Future work on the help system could incorporate a user model that would maintain a database of different users, their habits and preferences The system could draw inferences about a user's capabilities and knowledge based on that information, and the results of such inferences could provide a basis for adaptive interfacing For example, if the system determined that a user had a large amount of experience with the software, the descriptions of

failures and pre-conditions could be shortened thereby simplifying the display and reducing the need for scrolling On the other hand, if the user was a comparative novice the system could provide detailed descriptions and additional instructions Such knowledge of a user's proficiency could determine the level of help to offer in other contexts

One other useful form of intelligent help to the SERA user would involve comparing the results of the analysis with previous results to identify similarities This "case-based" approach could be accomplished through pattern-matching in the database of previous reports By drawing the user's attention to other reports where the same or similar types of failure have occurred, the investigator might discover valuable insights in the factors that other users have considered in similar accident situations

Another future enhancement could provide help to the user when an action is performed that has no effect Examples of this type of action include

- clicking the dimmed "Next" button when neither "Yes" nor "No" has been selected in a question screen, or
- clicking a node in the flowchart that has not yet been visited and not at the top of one of the three branches

The system could detect these actions and provide information detailing why they had no effect

## References


1 Anon (1999) Flight Safety for the Canadian Forces (A-GA-135-001/AA-001) Ottawa, ON, Canada Department of National Defence, Directorate of Flight Safety

2 Cohen, L. J (1977) The Probable and the Provable Oxford, United Kingdom: Clarendon Press

3 Edwards, E (1988) Introductory overview In, E L Weiner and D C Nagel (Eds ), Human Factors in Aviation San Diego, CA, USA Academic Press, Inc 3-25

4 Endsley, M R (1993) Situation awareness in dynamic decision making. Theory In, Proceedings of the 1st International Conference on Situational Awareness in Complex Systems

5 Hendy, K C (2002) A Tool for Human Factors Accident Investigation, Classification and Risk Management – PCTACT (DCEIM TR 2002) North York, Ontario, Canada Defence and Civil Institute of Environmental Medicine

6 Hendy, K C , Beevis, D , Lichacz, F , and Edwards, J L (2001) Analyzing the cognitive system from a perceptual control theory point of view In, State of the Art Review. Wright Patterson AFB, Dayton, OH, USA Crew Systems Ergonomics/Human Systems Technology Information Analysis Center (in press)

7 Hendy, K C , East, K P , and Farrell, P S E (2000) An information processing model of operator stress and performance In, P A Hancock and P A Desmond (Eds ), Stress, Workload and Fatigue Theory, Research, and Practice Mahwah, NJ, USA Lawrence Erlbaum Associates, Publishers 34-80

8 Hendy, K C , and Farrell, P S (1997). Implementing a model of human information processing in a task network simulation environment (DCIEM 97-R-71) North York, Ontario, Canada Defence and Civil Institute of Environmental Medicine

9 Hendy, K C , and Ho, G (1998) Human factors of CC-130 operations — Volume 5 Human factors in decision making (DCIEM 98-R-18) Toronto, Ontario, Canada Defence and Civil Institute of Environmental Medicine

10 Hendy, K C , Liao, J , and Milgram, P. (1997) Combining time and intensity effects in assessing operator information processing load Human Factors, 39(1), 30-47

11 Hendy, K C , and Lichacz, F (1999) Controlling error in the cockpit In, R S Jensen (Ed ) Proceedings of the 10th International Symposium on Aviation Psychology Columbus, OH, USA The Aviation Psychology Laboratory, The Ohio State University 658-663

12 McCann, C., and Pigeau, R (1999) Clarifying the concepts of control and of command In, Proceedings of Command and Control Research and Technology Symposium Washington, DC, USA CCRP, Dept of Defense 475-490

13 McNeill, D , and Freiberger, P (1993) Fuzzy Logic New York, NY, USA Simon and Schuster

14 Powers, W T (1973). Behavior The control of perception New York, NY, USA· Aldine De Gruyter

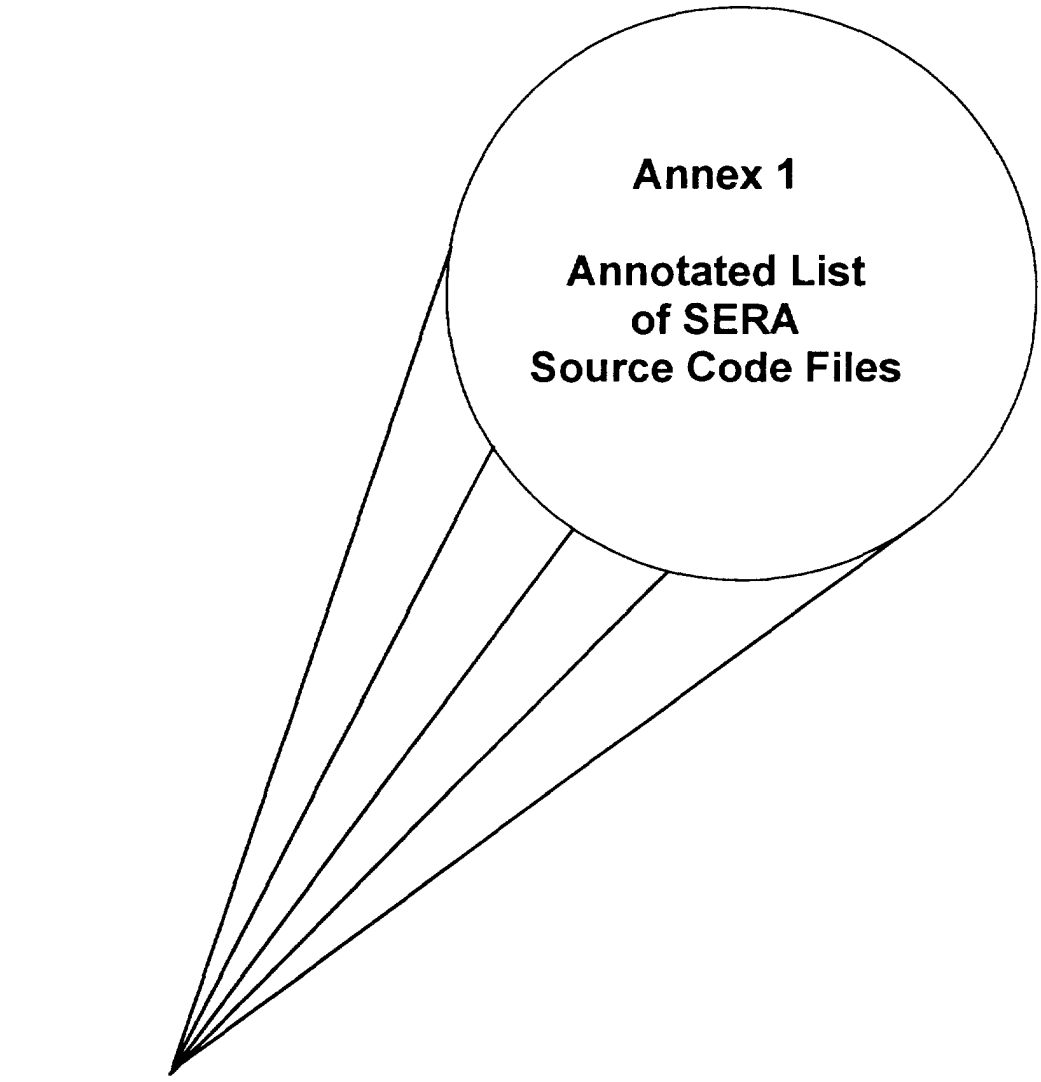
15 Reason, J. (1990). Human Error New York, USA Cambridge University Press

16 Shappell, S A , and Wiegmann, D A (2000) The Human Factors Analysis and Classification System–HFACS (DOT/FAA/AM-00/7) Washington, DC, USA Office of Aviation Medicine, Federal Aviation Administration

17 Wickens, C D , and Hollands, J G (1999) Engineering Psychology and Human Performance (Third Edition) Upper Saddle River, NJ, USA Prentice Hall

# Annexes

1 Annotated List of SERA Source Code Files




Artificial Intelligence
Management and Development Corporation

**Collage.jpg**

- This image file contains the collage that is displayed on the splash screen.

**Dialogs.java**

- This file contains the Java code for the dialogue boxes, including the HFACS window, the help prompt, the pop-up help windows and the "save changes" prompt.

**Flowchart.java**

- This file contains the Java code necessary for the SERA Flowchart window.

**Main.java**

- This file contains the Java code that serves as the main entry point when the application is launched.

**MainWindow.java**

- This file contains the Java code necessary for the main SERA window.

**SERA.mcp**

- This is the Metrowerks CodeWarrior project file.

**Title.jpg**

- This image file contains the graphic of the SERA title that is displayed above the collage on the splash screen and at the top of all subsequent screens.

**Tree.txt**

- This file contains the text of questions, conclusions and pre-conditions, as well as information on the relationships among the nodes in the SERA decision tree.

## DOCUMENT CONTROL DATA SHEET

**1a. PERFORMING AGENCY**
Artificial Intelligence Management and Development Corporation, 206 Keewatin Avenue, Toronto, ON M4P 1Z8 CANADA

**2. SECURITY CLASSIFICATION**
UNCLASSIFIED
- Unlimited distribution -

**1b. PUBLISHING AGENCY**
DRDC Toronto

**3. TITLE**
(U) Design and Implementation of a Software Tool for Human Factors Investigation and Classification (PCTACT)

**4. AUTHORS**
Jack L Edwards

**5. DATE OF PUBLICATION**
August 31 , 2002

**6. NO. OF PAGES**
41

**7. DESCRIPTIVE NOTES**

**8. SPONSORSHIP/MONITORING/CONTRACTING/ASKING AGENCY**
Sponsoring Agency
Monitoring Agency
Contracting Agency DRDC Toronto
Tasking Agency

| 9. ORIGINATOR'S DOCUMENT NO. | 10. CONTRACT, GRANT AND/OR PROJECT NO. | 11. OTHER DOCUMENT NOS. |
|---|---|---|
| Contract Report CR 2002-168 | PWGSC W7711-01-7763/001/TOR, 131f11 | AC242 |

**12. DOCUMENT RELEASABILITY**
Unlimited announcement

**13. DOCUMENT ANNOUNCEMENT**
Unlimited announcement

**14. ABSTRACT**

A software tool was designed and implemented that leads accident investigators through the steps of a Systematic Error and Risk Analysis (SERA), a classification scheme based on Perceptual Control Theory and developed at DRDC Toronto The software presents an investigator with a series of questions about an accident and generates conclusions about the nature of the failure and its probable pre-conditions A graphical depiction of the decision tree allows users to navigate easily among the steps of the analysis At the end of the process, the software produces a report detailing failures and pre-conditions, and providing equivalent terminology from the AGA 135 HFACS classification scheme

A help system was developed that makes context-sensitive help available to the user at various stages of the process In preliminary work to lay a foundation for intelligent aiding, users' activities are tracked by the software in a way that can be used in future to provide intelligent and adaptive help To illustrate the potential use of the tracking mechanism, the software was designed to monitor user actions and offer help whenever there is a long delay without input

**RÉSUMÉ**

On a conçu et mis en œuvre un outil logiciel qui aide les enquêteurs d'accident à exécuter les étapes d'une analyse systématique des erreurs et du risque (SERA), système de classification basé sur les principes du contrôle perceptif et développé par le RDDC Toronto Le logiciel présente à l'enquêteur une série de questions sur un accident et génère des conclusions sur la nature de la défaillance et les conditions préalables probables Une représentation graphique de l'arbre de décision permet aux utilisateurs de naviguer aisément parmi les étapes de l'analyse À la fin du processus, le logiciel produit un rapport détaillant les défaillances et les conditions préalables et fournissant la terminologie équivalente du système de classification du SACR AGA 13

On a développé un système d'aide contextuelle auquel l'utilisateur peut avoir recours aux diverses étapes du processus Au stade préliminaire en vue d'établir une fondation pour l'aide intelligente, les activités des utilisateurs sont suivies par le logiciel d'une façon qui pourra être utilisée à l'avenir pour offrir de l'aide intelligente et adaptative À titre d'illustration de l'utilisation potentielle du mécanisme de suivie des activités, le logiciel a été conçu pour surveiller les actions de l'utilisateur et offrir de l'aide lorsqu'il y a un intervalle prolongé sans entrée

15 KEYWORDS, DESCRIPTORS OR IDENTIFIERS
(U) HUMAN ENGINEERING TOOLS, HUMAN FACTORS ENGINEERING, SYSTEMATIC ERROR AND RISK ANALYSIS TOOL, SERA

#518636